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# Terrestrial small mammal community structure in an anthropogenically-altered moist semi-deciduous forest zone of Ghana

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## Abstract

The small mammal community structure of the Moist Semi-Deciduous forest zone of the Amansie West District of the Ashanti Region of Ghana was studied. A total effort of 2,340 trap-nights yielded 201 individuals belonging to 11 rodents species (order Rodentia) and three shrew species (order Soricomorpha). Additionally, 13 rodent species belonging to five families, Thryonomidae (1 species), Cricetidae (1 species), Anomaluridae (3 species), Sciuridae (6 species) and Hystricidae (2 species) were observed via ad hoc walks. The relative abundance ranged from 1.9% for the OKF to 17.2% for the ORA. Small mammal diversity was highest and lowest at the PKF and OKF, respectively. The species comprised forest specialists and species adapted to habitats ranging from grassland to forest clearings. Two species, *Lophuromys sikapusi*, and *Mus musculoides* were common to all the sites, and together with *Mastomys natalensis*, constituted about 70% of the total number of captures. The fresh biomass of species varied, with the weight of males being slightly higher than that of their female counterparts. About 60% of rodents showed signs of sexual activity. Species of conservation concern and management value included *Crocidura grandiceps* (Near Threatened) and the West African endemics *Malacomys edwardsi* and *Hylomycus alleni*.

***Keywords:*** Biodiversity conservation, Forest reserve, Moist semi-deciduous forest, Small mammals of Ghana, Sacred grove



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## 1. Introduction

West Africa has witnessed a large-scale decline in wildlife abundance and diversity. The main reason for this decline is the rapid and widespread loss and fragmentation of original habitats (Decher, 1997). The replacement of forests by species-poor monocultures or private farms has lead to the destruction and isolation of originally unbroken forest that served as unique refugia for many forest dependent species.

Deforestation and forest degradation constitute major threats to Ghana's biodiversity. Even though comprehensive, qualitative assessments of deforestation and forest degradation are currently not available for the country, the official rate of deforestation estimates are in the region of 2% since 1990 (FAO, 2010). The only remaining forest remnants are located within forest reserves (Oates, 1999) and in traditionally managed forest remnants (sacred groves) (Decher and Abedi-Lartey, 2002). Consequently, many wildlife species in the country have become increasingly rare and vulnerable.

The Moist Semi-Deciduous forest of the Amansie West District of the Ashanti Region of Ghana is an important area for wildlife and other biological diversity (Ofori et al., 2012). This area which was once covered by a continuous closed-canopy forest that was described as "*Celtis-Triplochiton*" Rainforest Association (Taylor, 1960), has undergone various levels of degradation as a result of negative anthropogenic activities such as "slash-and-burn" farming, illegal logging and small scale mining. The resultant vegetation is a patchy network of fragmented secondary forests at different land use stages, farmbush, grassy clearings and marshland. The only examples of the natural flora at the area are located within two forest reserves, the Gyeni River and Gyemera forest reserves, and a few sacred groves.

Even though the Moist Semi-Deciduous forest cover in the area continues to decline, our knowledge of the faunal communities in the area is still patchy. There is therefore the need to collect such scientific information in the area before the opportunities diminish completely to the ever accelerating deforestation in the region.

Small mammals (rodents and shrews) are an extra ordinary diverse group of mammals that inhabit almost every habitat. They constitute the largest group of mammals and are important functional component of tropical forest ecosystems. They influence the structure and composition of forests through consumption and distribution of foliage, seeds and fungal spores, and as pollinators and prey species for other animals such as snakes, predatory birds and mammals, which are often of greater conservation concern (Carey and Johnson, 1995; Pearson, 2000; Attuquayefio and Wuver, 2003; Angelici and Luiselli, 2005; Chung and Corlett, 2006). The rapid turn-over and unique response of small mammals to habitat disturbance make them important bio-indicators of ecosystem health.

The present study surveyed the small mammal communities of the Moist Semi-Deciduous forest zone of the Amansie West District of the Ashanti Region of Ghana. The specific objectives were to document for the study area (i) small mammal species abundance, diversity, composition and distribution, (ii) small mammal species biomass, sex ratio, breeding conditions, and (iii) conservation and management value of small mammals at the area.

## 2. Materials and methods

### 2.1. Study area

The study area (6° 28'- 6° 38'N; 1° 53'- 2° 01'W) is located in the Amansie West District, in the Ashanti Region of Ghana, approximately 35 km southwest of the regional capital, Kumasi. The area, which covers about 165 $km^2$ total land area with altitude ranging from 200 to 500 meters above mean sea level (Amsl), lies within the Moist Semi-Deciduous Forest and Wet Semi-Equatorial Climatic zones, with a bimodal rainfall distribution and mean annual rainfall ranging from 1500 to 1700 mm (Taylor, 1960). The major rainy season occurs from April to July/August, peaking in June, while the minor rainy season runs from September to October. The major dry season runs from December to March, with mean annual temperature ranging from 22 °C in August to 36 °C in March. The relative humidity ranges from 70% to 90% (Dickson and Benneh, 1980).

The area is drained by the southwesterly flowing Bonte River. The geology of the area is dominated by the Birimian Supergroup metasedimentary and metavolcanic rocks and various granitoid intrusions (Dickson and Benneh, 1980). The vegetation consists of dense undergrowth and forest tree species of the *Celtis-Triplochiton* Association, dominated by *Celtis mildbraedii*, *Triplochiton scleroxylon* (wawa), *Ceiba pentandra* (silk cotton), *Milicia excelsa* (odum), *Khaya ivoriensis* (mahogany), *Termilaria ivoriensis* (emire), *Terminalia superba* (ofram) and *Bambusa* sp. (bamboo) (Taylor, 1960).

### 2.2. Live-trapping of small mammals

Small mammals (rodents and shrews) surveys were conducted in two trapping sessions; one trapping session in March (dry season) and the other in September (minor wet season) 2011. The study sites included two forest reserves, Gyeni River (GRFR) and Gyemira Forest Reserves (GFR), two sacred groves, Prako kwaye (PKF) and Okyem kwaye (OKF) forests, and an Off-reserve area (ORA) composed largely of a mosaic of small forest remnants, thickets, grassland, shrubland, and farmbush. The geo-location, size and vegetation cover types of each study site are shown in Table 1.

Survey techniques followed those described by Voss and Emmons (1996) and Martin et al. (2001), and complied with recommended guidelines and standard methods for mammal field work (Animal Care and Use Committee 1998; Wilson et al., 1996). Small mammals were live-trapped along three line transects established at each study site. Transects were placed to reflect the different cover types and levels of disturbance at each study site. Each transect had 20 trap-stations placed at 10 m intervals, except those of the PKF and OKF, where there were 10 trap-stations per transect. Each trap-station was supplied with one Sherman collapsible live-trap (H.B. Sherman Traps Inc., Florida, USA) baited with a mixture of corn meal and peanut butter. In addition, two pitfall lines with plastic drift fence, each comprising 15 pitfall buckets spaced at about 5 m intervals, were installed at each study site. Traps were set in the day and checked the following morning between 07:00 and 09:00 GMT for three consecutive nights in each trapping session. There were therefore an overall total of 2340 trap-nights (1440 Sherman trap-nights and 900 pitfall trap-nights).

**Table 1.** Description of the Study Sites

| STUDY SITE | COORDINATES | SIZE ($m^2$) | VEGETATION DESCRIPTION |
|---|---|---|---|
| **GFR** | 6°36'00N; 1°55'00W | 63,000 | Old growth forest- *Celtis* sp., *Triplochiton* sp, farm grassland/shrubland, *Chromolaena odorata*, *Panicum maximum, Bambusa* sp. |
| **GRFR** | 6°30'00N; 1°55'00W | 22,000 | Old growth forest- *Celtis* sp., *Triplochiton scleroxylon*, *Milicia excelsa*, *Bambusa* sp. |
| **PKF** | 6°33'00N; 1°53'30W | 1,000 | Old growth forest- *Celtis* sp., *Triplochiton scleroxylon*, farmbush, *Chromolaena odorata*, *Bambusa* sp. |
| **OKF** | 6°34'30N; 1°53'00W | 1,000 | Old growth forest- *Celtis* sp., *Triplochiton scleroxylon*, farmbush, *Chromolaena odorata.* |
| **ORA** | 6°32'00N; 1°57'00W | 80,000 | Grassland/shrubland, thicket, farmbush, marshy areas, *Chromolaena odorata*, *Panicum maximum.* |

Captured animals were identified on the spot (where possible), weighed, sexed (using the anal-genital distance, which is longer in males), aged (assigned to three age classes: juvenile, subadult and adult using a combination of their weight and expert opinion), checked for reproductive condition (abdominal or scrotal testes in males and enlarged nipples, perforate vaginas and pregnancy in female) (Attuquayefio and Wuver, 2003), marked by toe clipping and then released at the point of capture or kept as voucher specimens for further identification. Field identifications were based on Rosevear (1969), Hutterer and Happold (1983) and Kingdon (2007).

Information on larger rodents such as squirrels, cane and giant rats, anomalures and porcupines was obtained via *ad hoc* observations and by interviewing local people, mainly hunters and farmers.

## 2.3. Analysis of data

The relative abundance ($R$) of small mammals was calculated as the total number of captured individuals per 100 trap-nights (1 trap-night = 1 trap set for 1 night) for each site. Thus,

$$R = \frac{N_i \times 100}{T_n},$$

where $N_i$ = total number of captured individuals and $T_n$ = total number of trap-nights. This capture per unit effort index is an acceptable way to communicate small mammal relative abundance.

Species diversity was estimated using the Shannon-Weiner Index ($H'$) (Stiling, 1998) as

$$H' = - \Sigma\, p_i * ln\, (p_i),$$

where $p_i$ = the proportion of the $i$th species in the total sample.

Similarity of small mammal composition between study sites was determined using the Sorenson's index ($S'$) (Krebs, 2001) as follows:

$$S' = \frac{2C}{a+b},$$

where $a =$ the number of species at the first study site, $b =$ the number of species at the second study site, and $C =$ the number of species common to the two sites.

Significance of differences in species richness, abundance and diversity between paired sites was estimated using the Least Significant Difference (*l.s.d*) calculated as 2*s.e.d*, where

$s.e.d = \sqrt{\frac{V^2}{n}}$, $V =$ Sample variance and $n =$ Sample size

All calculations were done using Microsoft Excel Version 2007. The trapping design was based on the assumption that (i) differences in captures represented proportional differences in species abundance and (ii) capture probabilities remain constant for each trap and during each trapping session.

## 3. Results

### 3.1. Small mammal species abundance, diversity, composition and distribution

A total of 201 individuals of 14 species belonging to 11species of rodents (orders Rodentia) and 3 species of shrews (order Soricomorpha) were captured from 2,340 trap-nights. The overall relative abundance of captured small mammals was therefore 8.6%. The rodents comprised the Allen's wood mouse (*Hylomyscus alleni*), the Dalton's mouse (*Myomys daltoni*), the Dephua mouse (*Dephomys defua*), the Edward's long-footed rat (*Malacomys edwardsi*), the Nagtglas' dormouse (*Graphiurus nagtglasii*), the Natal's multimammate rat (*Mastomys natalensis*), the Rudd's brush-furred rat (*Uranomys ruddi*), the Rusty-bellied rat (*Lophuromys sikapusi*), the Temminck's pigmy mouse (*Mus musculoides*), the Tullberg's soft-furred rat (*Praomys tullbergi*) and the Striped grass rat (*Lemniscomys striatus*). The total relative abundance of each species is shown in Table 3. The shrews were composed of the Olivier's shrew (also known as the African giant shrew) (*Crocidura olivieri*), the Lamotte's shrew (*Crocidura lamottei*) and the Large-headed shrew (*Crocidura grandiceps*).

In addition, 13 rodent species from 5 families, Thryonomidae (1 species), Cricetidae (1 species) Anomaluridae (3 species) Sciuridae (6 species) and Hystricidae (2 species) were observed via *ad hoc* walks, bringing the overall total number of species at the study area to 25 (Table 2).

**Table 2.** Distribution and Conservation Status of Small Mammals at the Study Area

| SCIENTIFIC NAME | COMMON NAME | STATUS (IUCN) | GFR | GRFR | OKF | PKF | ORA |
|---|---|---|---|---|---|---|---|
| **RODENTIA** | | | | | | | |
| **Muridae** | | | | | | | |
| *Dephomys dephua* | Defua rat | LC | | | | | * |
| *Hylomyscus alleni* | Allen's wood mouse | LC | | * | | | * |
| *Lemniscomys striatus* | Striped grass rat | LC | * | | | | * |
| *Lophuromys sikapusi* | Rusty-bellied rat | LC | * | * | * | * | * |
| *Malacomys edwardsi* | Edward's long-footed rat | LC | * | | | * | |
| *Mastomys natalensis* | Natal's multimammate rat | LC | * | | | | * |
| *Mus musculoides* | Temminck's pigmy mouse | LC | * | * | * | * | * |
| *Myomys daltoni* | Dalton's mouse | LC | | | * | | * |
| *Praomys tullbergi* | Tullberg's soft-furred rat | LC | * | * | | * | * |
| *Uranomys ruddi* | Rudd's brush-furred rat | LC | * | * | | | * |
| **Myoxidae** | | | | | | | |
| *Graphiurus nagtglasii* | Nagtglas' dormouse | LC | | | | * | |
| **Thryonomidae** | | | | | | | |
| *Thryonomys swinderianus* | Marsh cane-rat | LC | | | | | * |
| **Cricetidae** | | | | | | | |
| *Cricetomys gambianus* | Giant-pouched rat | LC | * | * | * | * | * |
| **Anomaluridae** | | | | | | | |
| *Anomalurus beecrofti* | Beecroft's flying squirrel | LC | * | * | * | * | * |
| *Anomalurus peli* | Pel's flying squirrel | NT | * | * | * | * | * |
| *Anomarulus pusillus* | Lesser anomalure | LC | * | * | | * | |
| **Sciuridae** | | | | | | | |
| *Protoxerus aubinii* | Slender-tailed squirrel | LC | * | * | * | * | |
| *Euxerus erythropus* | Stripped ground squirrel | LC | * | | | | * |
| *Heliosciurus rufobrachium* | Red-legged sun squirrel | LC | * | * | * | * | * |
| *Epixerus ebi* | Western palm squirrel | LC | | | | | * |
| *Paraxerus poensis* | Green squirrel | LC | * | * | | * | |
| *Funiscurus pyrropus* | Fire-footed squirrel | LC | * | * | * | * | |
| **Hystricidae** | | | | | | | |
| *Hystrix cristata* | Crested porcupine | LC | * | * | * | * | * |
| *Atherurus Africana* | Brush-tailed porcupine | LC | * | * | * | * | * |
| **INSECTIVORA** | | | | | | | |
| **Soricidae** | | | | | | | |
| *Crocidura olivieri* | Olivier's shrew | LC | * | * | * | * | |
| *Crocidura lamottei* | Lamotte's shrew | LC | * | | | | |
| *Crocidura grandiceps* | Large- headed shrew | NT | | | | * | |

*Legend: LC = Least Concern; NT = Near Threaten*

**Table 3.** Small Mammal Species Richness Relative Abundance and Diversity at the Study Area.

| SMALL MAMMAL SPECIES | STUDY SITES | | | | | TOTAL | Relative abundance (%) |
|---|---|---|---|---|---|---|---|
| SCIENTIFIC NAME | GFR | GRFR | OKF | PKF | ORA | | |
| **RODENTIA** | | | | | | | |
| **Muridae** | | | | | | | |
| *Dephomys dephua* | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 2 (2.2%) | **2** | **0.09** |
| *Hylomyscus alleni* | 0 (0%) | 1 (3.7%) | 0 (0%) | 0 (0%) | 1 (1.1%) | **2** | **0.09** |
| *Lemniscomys striatus* | 8 (12.7%) | 0 (0%) | 0 (0%) | 0 (0%) | 9 (9.7%) | **17** | **0.73** |
| *Lophuromys sikapusi* | 8 (12.7%) | 14 (51.9%) | 2 (28.6%) | 4 (36.4%) | 37 (39.8%) | **65** | **2.78** |
| *Malacomys edwardsi* | 1 (1.6%) | 0 (0%) | 0 (0%) | 1 (9.1%) | 0 (0%) | **2** | **0.085** |
| *Mastomys natalensis* | 13 (20.6%) | 0 (0%) | 0 (0%) | 0 (0%) | 20 (21.5%) | **33** | **1.41** |
| *Mus musculoides* | 27 (42.9%) | 4 (14.8%) | 3 (42.9%) | 2 (18.2%) | 10 (10.8%) | **46** | **1.97** |
| *Myomys daltoni* | 0 (0%) | 0 (0%) | 1 (14.3%) | 0 (0%) | 4 (4.3%) | **5** | **0.21** |
| *Praomys tullbergi* | 1 (1.6%) | 4 (14.8%) | 0 (0%) | 1 (9.1%) | 6 (6.5%) | **12** | **0.51** |
| *Uranomys ruddi* | 1 (1.6%) | 2 (7.4%) | 0 (0%) | 0 (0%) | 4 (4.3%) | **7** | **0.3** |
| **Myoxidae** | | | | | | | |
| *Graphiurus nagtglasii* | 0 (0%) | 0 (0%) | 0 (0%) | 1 (9.1%) | 0 (0%) | **1** | **0.04** |
| **INSECTIVORA** | | | | | | | |
| **Soricidae** | | | | | | | |
| *Crocidura olivieri* | 3 (4.8%) | 2 (7.4%) | 1 (14.3%) | 1 (9.1%) | 0 (0%) | **7** | **0.3** |
| *Crocidura lamottei* | 1 (1.6%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | **1** | **0.04** |
| *Crocidura grandiceps* | 0 (0%) | 0 (0%) | 0 (0%) | 1 (9.1%) | 0 (0%) | **1** | **0.04** |
| **Total no. of Individuals** | **63 (100%)** | **27 (100%)** | **7 (100%)** | **11 (100%)** | **93 (100%)** | **201** | |
| **Total no. of Species** | **9** | **6** | **4** | **7** | **9** | **14** | |
| **Relative abundance (R) (%)** | **11.7** | **5** | **1.9** | **3.1** | **17.2** | **8.6** | |
| **Diversity ($H'$)** | **1.6** | **1.4** | **1.3** | **1.8** | **1.7** | **1.9** | |
| **exp$H'$** | **5.1** | **4.1** | **3.9** | **5.9** | **5.7** | **6.8** | |

The species richness varied from 9 to 4 species, with the GFR and the ORA jointly recording the highest number of species (64% of the total number of captured species) and the OKF the lowest number species (29% the total number of captured species) (Table 3). The number of species increased with increasing trapping effort. The species accumulation curve did not reach asymptotes for all the study sites (Fig. 2), indicating high possibility of encountering additional species with extended trapping effort.

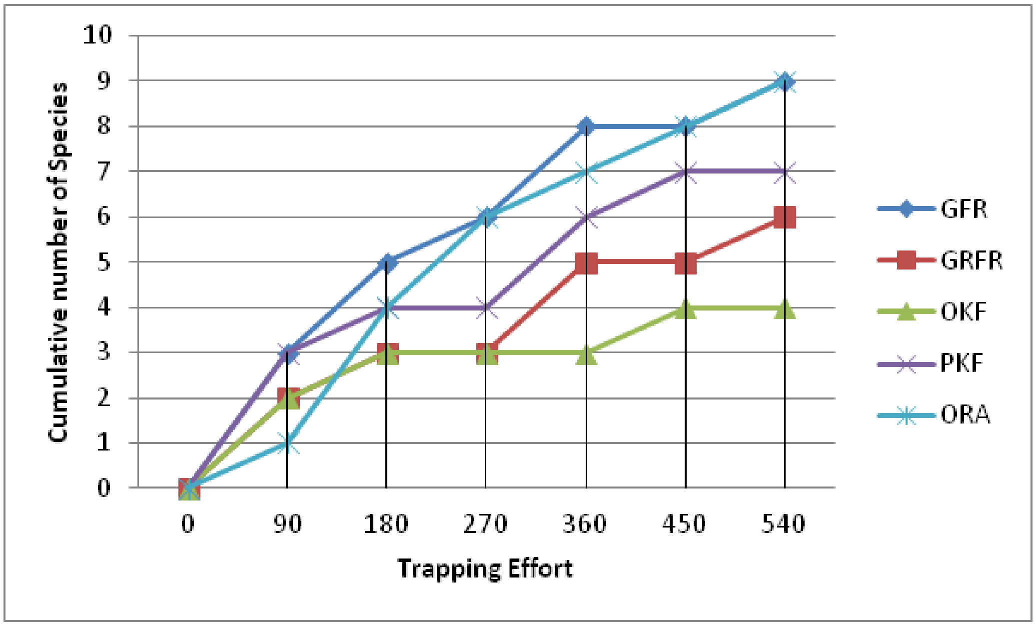


**Figure 2.** Small Mammal Species Accumulation for the Study Sites

The relative abundance and diversity of small mammals varied between study sites. The relative abundance ranged from 1.9% to 17.2%, and was significantly higher at the ORA (d > 2*s.e.d*). The PKF and OKF recorded the greatest and lowest species diversity with exp$H'$ = 5.9 and 3.6, respectively. The overall species diversity for the study area was however, greater than the diversity at any one site ($H'$ = 1.9; exp $H'$ = 6.8) (Table 3).

Small mammal species composition was reflective of the habitat types, density of vegetation cover and levels of disturbance at the study area. The species comprised a mixture of both forest specialists and those adapted to a wider range of habitats ranging from grassland to forest clearings. All the captured species, except *L.* Sikapusi and *M. musculoides*, were present in only a subset of the study sites. For instance, *Crocidura lamotteio* was captured at only the GFR, *D. duphua* at only the ORA, *G. nagtglasii* and *C. grandiceps* at only the PKF, *H. alleni* at the GRFR and ORA, *L. striatus* at the GFR and ORA, *M. edwardsi* at the GFR and PKF, *M. natalensis* at the GFR and ORA, and *M. daltoni* at the OKF and ORA. The PKF harboured the highest number of forest dependent small mammal species.

The similarities of species composition between the forest reserves and the ORA was relatively high ($S'$ = 0.7), but was low between the sacred groves (PKF and OKF) and the ORA ($S' \leq 0.5$).

## 3.2. Biomass, sex ratio and breeding conditions of small mammals

The biomass (mean fresh weight) of small mammal species varied during the study. For the rodents, *L. sikapusi* recorded the highest biomass with 69 g (n = 65; range = 30-99), while *M. musculoides* recorded the lowest biomass with 10 g (n = 46; range = 7 – 16 g). For the shrews, the mean fresh weight ranged from 19 g to 22 g, with *C. olivieri* and *C. grandiceps* recording the highest and lowest biomass, respectively (Table 4). In general, the males were heavier than the females.

**Table 4.** Biomass, Sex Ratio and Breeding Conditions of Captured Small Mammals at the Study Area

| SCIENTIFIC NAME | | WEIGHT (g) | | SEX | | BREEDING CONDITION | |
|---|---|---|---|---|---|---|---|
| **RODENTS** | **No. of individuals (n)** | **Range** | **Mean** | **Male** | **Female** | **Yes** | **No** |
| *D. dephua* | 2 | 49-53 | 51 | 1 | 1 | 1 | 1 |
| *H. alleni* | 2 | 24-38 | 31 | 1 | 1 | 1 | 1 |
| *L. striatus* | 17 | 32-69 | 50 | 9 | 8 | 11 | 6 |
| *L. sikapusi* | 65 | 30-99 | 69 | 40 | 25 | 39 | 26 |
| *M. edwardsi* | 2 | 42-50 | 46 | 1 | 1 | 1 | 1 |
| *M. natalensis* | 33 | 35-75 | 52 | 27 | 6 | 19 | 14 |
| *M. musculoides* | 46 | 7-16 | 10 | 28 | 18 | 25 | 21 |
| *M. daltoni* | 5 | 21-33 | 26 | 2 | 3 | 2 | 3 |
| *P. tullbergi* | 12 | 33-50 | 41 | 7 | 5 | 8 | 4 |
| *U. ruddi* | 7 | 25-39 | 32 | 6 | 1 | 4 | 3 |
| *G. nagtglasii* | 1 | - | 24 | 1 | 0 | 1 | 0 |
| **SHREWS** | | | | | | | |
| *C. olivieri* | 7 | 18-29 | 22 | 5 | 2 | 2 | 5 |
| *C. lamottei* | 1 | - | 21 | 1 | 0 | 0 | 1 |
| *C. grandiceps* | 1 | - | 19 | 0 | 1 | 0 | 1 |

Overall, males formed majority (about 64%) of the total captures, even though the sex ratio of 10 species (seven rodents and three shrews) did not differ much from 1:1. The ratio of male to female was about 1.5:1 for *L. sikapusi* and *M. musculoides*. Male dominance was more evident for *M. natalensis*, with males accounting for about 82% of the total number of individuals captured (33). Signs of breeding activities were evident throughout the study. About 60% of rodents recorded showed some signs of breeding activities (abdominal or scrotal testes in males and enlarged nipples or perforate vaginas or pregnancy in females) (Table 4).

## 3.3. Species of conservation concern

*Malacomys edwardsi, H. alleni* and *C. grandiceps* are endemic to West Africa and thus, are species of special interest and management value (Weber and Fahr, 2007). *Crocidura grandiceps* in addition, is listed as Near Threatened (NT) on the IUCN Red List (IUCN, 2010) (Table 3). The Pel's flying squirrel (*Anomalurus peli*) and crested and brush-tailed porcupines are listed on Schedule III of the CITES scheme and Schedule II of the National Species Conservation List, and are completely protected at some period of the year. The striped ground squirrel (*Euxerus erythropus*), the slender-tailed squirrel (*Allosciurus aubinni*), and the red-legged sun squirrel (Heliosciurus *rufobrachium*) are listed on Schedule III of the National Species Conservation list. The hunting, capturing or destroying of any of these species is absolutely prohibited between 1 August and 1 December ("Closed season").

## 4. Discussion

### 4.1. Small mammal species abundance, diversity, composition and distribution

The study area harbored a diverse assemblage of small mammals with different habitat associations including true forest species, and those that are adapted to grassland, farmbush and forest clearings. Even though the species accumulation curve for the study sites did not reach asymptote, which meant that our sample did not include all the species at the study area, we captured greater number of rodents and shrews than those captured in the Moist Semi-deciduous forest zone of the Western Region (Vordzogbe et al., 2006) and Eastern Region of the country (Weber and Fahr, 2007), respective, and in the Dry Semi-deciduous forest zone of the Volta Region (Decher and Abedi-Lartey, 2002), as well as those captured in the forest transition zone of the Brong-Ahafo Region (Attuquayefio, 2008). Our species list, however, fell short of what was reported from the Kakum National Park located in the Moist Semi-deciduous forest zone of the Central Region of Ghana (Yeboah, 1998).

Small mammal species diversity and composition correlates with habitat structure and resource abundance (Ryan and Attuquayefio, 2000). In general, habitats with more stable ecosystems and dense vegetation cover support more diverse small mammal species (Attuquayefio and Wuvor, 2003; Scott et al., 2006). Although this study did not address the density of plant cover in the various sites, it seems reasonable to infer that the dense vegetation and ground litter cover accounted for the high abundance and richness of small mammals at the area. The different levels of disturbances and land use practices especially in the off-reserve area may have created a variety of micro-habitats with suitable cover types and important ecological features such as availability of enough food, nesting and hiding places for rodents (Gebresilassie et al., 2004; Lambert et al., 2006).

The species composition of the present study also corresponded well with the general land use practices, vegetation covers and levels of degradation in the area. For instance, the Natal's multimammate rat and Rudd's brush-furred rat are association with grassland forest clearings and farmbush. The Rusty-bellied rat is also reported to have preference for farmbush, shrubland and open habitats within forests (Decher and Abedi-Lartey, 2002). The shrew *C. olivieri* is known from a variety of habitats including forest, clearings in the forest zone, farmbush, shrubland and grassland (Decher et al., 1997), while the Temminck's pigmy mouse is a habitat generalist that can successfully inhabit any vegetation type except in mangroves and coastal swamps, and Tullberg's soft-furred rat is a secondary forest species (Decher and Abedi-Lartey, 2002).

The vegetation cover in the ORA was mainly a mosaic of cocoa farm, farmbush, grassy clearings, shrubland and marshland. Even though the forest reserves (GFR and GRFR) and the sacred groves (OKF and PKF) were supposed to contain pristine forest, these areas have undergone various degrees of degradation resulting from farming encroachment and illegal logging. The occurrence of forest-dependent species such as *H. alleni* in the GRFR and ORA, *M. edwardsi* in the GFR and PKF, and *P. tullbergi* in the GRFR, GFR, PKA and ORA however, implies that the forest reserve, sacred groves and off-reserve areas still have vegetation covers that support the survival, growth and reproduction of these species. The occurrence of *C. grandiceps*, which is listed as Near Threatened on the IUCN Red List (IUCN, 2010) at the Prako kwaye sacred grove supported the claim that traditionally managed forests harbor exclusive forest species and function as refugia for small mammal fauna that are naturally rare (Decher et al., 1997).

### 4.2. Biomass, sex ratio and breeding conditions of small mammals

The sex ratio, biomass, and levels of breeding activity of small mammals could be used as a measure of the ecological "health" of an ecosystem. In the present study, the sex ratio of 10 species did not differ significantly from 1:1, even though males formed majority of the captured species at the study area. The slightly higher number of males may be due to their greater activities especially during the breeding season when males cover wider areas in search of potential mating partners. Reproductively active rodents were observed in all species during at least one trapping session of the study. The high percentage of rodents with signs of breeding activities suggested a thriving and stable small mammal community at the study area.

In conclusion, this study presents the status of small mammalian fauna as summarized by measures of species diversity, relative abundance, composition and distribution at the study area. This is useful in characterizing the environment and establishes a baseline for future assessment and long-term monitoring. The study also highlights the importance of the Moist Semi-Deciduous forest of the Amansie West District of the Ashanti Region of Ghana as habitats for small mammal.

Degradation of the forest in the region as a result of negative anthropogenic activities such as illegal logging, small-scale mining operations and poor farming practices, however, is a threat to the forest-dependent small mammals, most of which are species of conservation concern and management value. It is therefore recommended that these activities should be checked by the appropriate authorities to help conserve the rich biodiversity of the area.

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